U.S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY RESEARCH INITIATIVE
ABSTRACT

PI: **George Engelhardt**   **Proposal No.: 99-0217**

Institution: **SRI International**

Collaborators: None

Title: **Deterministic Prediction of Corrosion Damage in High Level Nuclear Waste**

In response to the Nuclear Energy Research Initiative solicitation DE-PS03-99SF21764, SRI International proposes to develop technologies for the deterministic prediction of corrosion damage in High Level Nuclear Waste (HLNW) containers. The proposed work is related to the New Technologies for Management of Nuclear Waste as presented in the Scope of Work and the Materials Science Field of R&D.

Safe disposal of our Nation's high level nuclear waste (HLNW) represents one of the greatest technical challenges of the twentieth and twenty-first centuries. The principal challenge is to ensure isolation of the waste from the biosphere for periods of up to 10,000 years under conditions that can only be estimated. The lack of existing databases for the corrosion of candidate alloys over times that represent even a small fraction of the intended service life means that we cannot rely on empirical methods to provide the design, materials selection, and reliability assessment information that is required to assure the public that the technology chosen for the disposal of HLNW is effective and safe. Instead, strategies based on the employment of deterministic models can be used, because the natural laws (laws of conversation) that are the foundation of these models are invariant with time. Existing deterministic models of general and localized corrosion allow us to predict the accumulation of corrosion damage in many systems. However, these models must be customized for predicting damage in the HLNW in a tuff repository .

SRI proposes to develop deterministic models and associated computer codes for predicting the evolution of corrosion damage (i.e., "integrated" damage) to HLNW containers in the Yucca Mountain repository . Corrosion processes that will be considered include general corrosion (oxidation), pitting corrosion, crevice corrosion, and stress corrosion cracking. The influence of radiolysis on the corrosion potential and hence on the corrosion rate will be included in the models. Special attention will be given to repassivation phenomena because they eventually determine the extent of damage, and attempts to quantitatively describe localized corrosion damage without the proper consideration of repassivation phenomena greatly underestimates the service lives of containers. Some important kinetic parameters (e.g. survival probabilities, delayed repassivation constants, exchanged current densities) will be determined experimentally for Alloy C-22 and carbon steel, which have been selected for fabricating the HLNW containers. The models will be customized to the conditions that the containers are expected to be exposed to over their design lives. These models will be used for extrapolating corrosion rate data obtained under "accelerated" laboratory conditions to the field, for predicting the fates of containers after exposure in the

repository under

various conditions (e.g., humid air, contract with dripping water, repository initiation), and for identifying conceptual design alternatives. To our knowledge, this will be the first application of fully deterministic models (i.e., models whose outputs are constrained by the natural laws) to the prediction of integrated corrosion damage on HLNW containers under conditions that realistically simulate the repository as it evolves with time (e.g., decaying dose rate and temperature and condensation of water within the vault). The successful completion of this work will greatly enhance our ability to predict the (corrosion) fate of HLNW containers and hence will instill public confidence that the technology can be effectively managed.

SRI International has already developed much of the technology and many of the facilities required for this work and offers experienced personal. Dr. Digby D. Macdonald, the proposed project supervisor, developed deterministic models for predicting damage due to general and localized corrosion. Dr. George Engelhardt, the project leader, also developed models for localized corrosion. He is an expert in mathematical modeling and developer of computer codes that will be used in this work. Many of the experimental techniques developed in previous work by SRI personnel will be used in the proposed research program.